CLAIMS

What is claimed is:

1. A method of producing highly-oriented fibrous mats having at least a 90% machine direction orientation using a wetlay machine having an open headbox and a moving wirebelt, said method comprising the steps of:

a) producing a thickened solution containing a plurality of suspended fibers, said thickened solution having a viscosity of equal to or greater than about 1.5 centipoise and said suspended fibers having fiber lengths of greater than about 0.6 cm and a modulus of at least 8 million psi;

b) introducing the thickened solution into a headbox of the wetlay machine and reducing its velocity to less than about 1/3 the velocity of said moving wirebelt; and

c) applying suction through said wirebelt to orient and pin said plurality of fibers on said wirebelt.

2. The method of claim 1 further comprising the step of adding an anti-foaming agent to said thickened solution.

3. The method of claim 1 further comprising the step of avoiding foaming agents within said thickened solution.

4. The method of claim 1 wherein said thickened solution is produced to have a constant viscosity under normal shear.

5. The method of claim 1 wherein said thickened solution is produced to have thixotropic properties.

6. The method of claim 1 wherein said thickened solution is thixotropic and produced to have a viscosity of at least 7 centipoise.

7. The method of claim 1 wherein said thickened solution contains a plurality of reinforcement fibers and thermoplastic components.

8. The method of claim 1 wherein said reinforcement fibers have fiber lengths in the range of about 0.6 cm to 6.35 cm.

9. The method of claim 9 wherein said reinforcement fibers have fiber lengths in the range of 1.9 cm to 3.2 cm.

10. The method of claim 7 wherein said reinforcement fibers have surface treatments designed to promote adhesion to said thermoplastic components.

11. The method of claim 7 wherein said reinforcement fibers are all made of one material and have at least substantially the same length and diameter.

12. The method of claim 7 wherein said reinforcement fibers are made of a mixture of materials, and have different lengths, diameters and compositions.

13. The method of claim 7 wherein concentration of reinforcement fiber components to thermoplastic components is in the range of 60-70% by weight of reinforcement fibers to 40-30% by weight of thermoplastic components.

14. The method of claim 7 wherein said thermoplastic component is selected from the group consisting of fibers, granular particles and flat platelets.

15. The method of claim 7 wherein said thermoplastic components are fibers with lengths in the range of 1/4" to 3/4" (0.6 to 1.9cm).

16. The method of claim 7 wherein said thermoplastic component is fibers selected from the group consisting of drawn and undrawn fibers.

17. The method of claim 7 wherein said thermoplastic components are made of the same material and are all substantially the same size.

18. The method of claim 7 wherein said thermoplastic components are made of a mixture of materials, and have different sizes and melting points.

19. The method of claim 7 further comprising the step of adding an additional material to the thermoplastic component selected from the group consisting of

fillers, antioxidants, coloring agents, electrically-conductive materials, electrically- insulating materials, thermally-conductive materials, thermally-insulating materials, adhesion aids, melt flow modifiers, cross-linking agents, chemically-reactive materials, biologically-reactive materials and molecular sieves.

20. The method of claim 1 further comprising the step of maintaining an open headbox.

21. The method of claim 1 further comprising the step of altering the internal shape of said headbox to eliminate deadspots containing eddy current formations.

22. The method of claim 21 wherein the step of altering the internal shape of said headbox comprises:

a) installing a plate extension in an upper portion of the headbox to deflect fibers and to prevent floating and entanglement of the fibers; and

b) installing a regulating weir at an upper portion of the headbox downstream of said plate extension.

23. The method of claim 21 wherein the step of altering the internal shape of said headbox comprises installing a streamlined portion which conforms to a natural streamline flow of stock within said headbox.

24. Fibrous mats produced from the method of claim 1.

25. Structural composites produced from the method of claim 1.

26. The method of claim 1 wherein said thickened solution is introduced into the headbox uniformly across a width of the headbox and substantially vertically upward against a liquid head to slow and turn the plurality of fibers toward the wirebelt with reduced turbulence and with reduced linear velocity.

27. The method of claim 1 wherein said thickened solution is introduced into the headbox in a substantially backward and upward direction from the direction of the wirebelt, and is slowed against a liquid head to reverse flow of said plurality of fibers in a smooth pattern and to present the plurality of fibers to the wirebelt with reduced velocity and turbulence.

28. The method of claim 1 wherein a ratio of linear wirebelt velocity to linear thickened solution velocity is at least 3:1.

29. A method of retrofitting an existing headbox of a wetlay machine so as to produce highly-oriented fibrous mats, comprising the steps of:

a) increasing head level within the headbox to increase headbox stock capacity; and

b) accelerating operating speed of a wirebelt within said wetlay machine beyond an operating speed of stock in the body of the headbox.

30. The method of claim 29 further comprising the step of installing a plate extension in an upper portion of the headbox to deflect fibers and to prevent floating and entanglement of the fibers.

31. The method of claim 29 further comprising installing a regulating weir at an upper portion of the headbox and downstream of a last suction box in said headbox.

32. The method of claim 29 further comprising installing a curved portion within said headbox to eliminate dead spots and corresponding eddy current formations.

33. The method of claim 32 wherein said curved portion is a streamlined portion which conforms to a natural streamline flow of stock within said headbox.

34. The method of claim 29 wherein said step of increasing head level comprises increasing head level height so that the head level is vertically higher than a highest vertical position of a highest suction box disposed under said wirebelt within said headbox.

35. The method of claim 34 wherein the head level height is set at a height in the range of 18-26cm higher than an exit point of said highest suction box disposed under said wirebelt within said headbox.

36. A mat comprising a plurality of discontinuous reinforcement fibers, wherein said reinforcement fibers have at least a 9 to 1 machine to cross direction mat strength ratio.

37. A mat comprising a plurality of discontinuous reinforcement fibers having at least a 90% machine direction orientation.

~~38. The mat of claim 37~~ wherein a basis weight of said mat falls within the range of 68 to 339 gm/square meters.

39. The mat of claim 37 wherein said mat further contains a thermoplastic component.

~~40.~~ A product comprising a plurality of mats, each of said mats comprising a plurality of discontinuous reinforcement fibers having at least a 90% machine direction orientation.

41. The product of claim 40 wherein at least one of said mats has been heated in an oven, compression molded, hot stamped, continuously formed in a belt press, continuously shape-formed by hot roller pressing, continuously shaped by reciprocal stamping, formed through pultrusion, or continuously manufactured to form structural rods, ropes and cables.

42. The product of claim 40, wherein each of said mats have different fiber components and fiber orientations.